Trial Key to the **WOODY DESERT FUNGI** found in the Pacific Northwest

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INTRODUCTION

The woody desert fungi represent a group of fungi mostly of interest to the mycologist or the curious. Most, with the possible exception of *Endoptychum agaricoides*, are too fibrous for the “pot”.

These inhabitants of the arid regions of the PNW are especially adapted to the climatic conditions experienced in the area east of the Cascade Mountains. They are able to fruit with a minimal amount of spring or fall moisture or from moisture derived from thunderstorms during the summer period.

Special adaptations protect the developing spores from heat and low humidity conditions. In the case of the Tulostomataceae the spores in the fruiting body mature below the soil surface and before the spore case is elevated above ground level by the elongation of the stipe. Spores are scattered principally by wind. This occurs over a considerable period of time as spores are liberated through a pore or released by the erosion of the spore case.

The collector of desert fungi needs to dig deeply and carefully to assure details of the stem base are preserved.

The following keys are divided into four parts. KEY I deals with the secotioid genera. It will be noted that this term is used in a broad sense and is not technically correct in some aspects. KEY II separates the genera of the Tulostomataceae and describes those species found in the PNW. A third key separates some species of the genus *Tulostoma* [by macroscopical characters]. Key IV to species of the latter genus uses microscopical features and includes principal macroscopical features. A page of schematic drawings is included to aid in recognition of desert fungi features.

Undoubtedly a number of unidentified *Tulostoma* species remain to be discovered in the PNW. The ten included are those identified by Dr. David Hosford, Central Washington University, who has been the chief researcher of the genus in the Pacific Northwest region.

[By 2004, more than 30 species of *Tulostoma* had been documented for the Pacific Northwest. See comments below in Introduction to *Tulostoma*.]

A KEY TO THE WOODY DESERT FUNGI OF PNW

1a Fruit body agaric-like; cap not expanding or almost lacking; spores not forcibly discharged; gills rudimentary or lacking. “Woody Mushrooms” Secotioid Fungi See Key I

1b Fruit body puffball-like with stems; spore case (peridium) opening by an apical pore, circumscissilely or by erosion of endoperidium over the top of the spore case. “Stalked Puffballs” Tulostomataceae See Key II

KEY I - SECOTIOID FUNGI

1a True cap almost lacking; black gill-like gleba extends from expanded apex of stipe; mature fruit body looks like a small black mop on end *Montagnea arenaria*

**FRUIT BODY** 8-30 cm tall, appearing much like a non-deliquescing *Coprinus.* **CAP** (pileus) merely an expanded disc of the stipe-columella, 1-3.5 cm wide, white to gray, often with remnants of “volva” over disc area. **GLEBA** gill-like, black at maturity, free from stipe and attached to margin at disc. **STIPE-COLUMELLA** long, 8-30 cm x 4-26 mm, woody, white, hollow, often somewhat scaly, tapering downwards, usually buried to half-way in sand. “**VOLVA**” small, often lost when specimen collected, outer part white. **BASIDIOSPORES** 12-19 x 6-11.2 um, blackish, ellipsoid to obovoid, with germ pore. **BASIDIA** clavate to pyriform, somewhat fuscous, almost square at distal end with blunt sterigmata, 4-spored. **HABIT** and **HABITAT** in sandy areas; scattered to gregarious. Reported as numerous in high plateaus of eastern Oregon.

1b Unexpanded cap present 2

2a Cap elongate; no partial veil present; resembling a slim non-deliquescing “shaggy mane” mushroom with woody stipe *Podaxis pistillaris*

**FRUIT BODY** 6-20 cm tall, consisting of two-layered spore case borne on strongly developed stipe extending through gleba as a columella. **SPORE CASE** 2-10 cm long x 1-4 cm wide, narrowly elliptic with rounded apex. **EXOPERIDIUM** a few appressed scales soon falling away. **ENDOPERIDIUM** at first shining, pallid to buff or brownish; in maturity wrinkling, pulling free from stipe and cracking longitudinally to accomplish spore dispersal. **GLEBA** dense, olive, reddish-brown to black. **STIPE-COLUMELLA** with stem portion to 8 cm long x 2-10 mm, covered with white brittle fibrils soon disappearing, stipe darkens and becomes longitudinally striate. **BASIDIOSPORES** 10-16 x 9-12 um (in some cases 12-20 x 12-15 um), reddish brown, with apical pore, often truncate, frequently with stump of pedicel. **CAPILLITIA** copious, colored, sparingly septate, rarely branched, in age spirally coiled. **BASIDIA** attached to threads in fascicles, 1-4 spored, the spores borne sessilely or upon very short sterigmata. **HABIT** and **HABITAT** in desert areas after rains; scattered.

2b Cap globose to subglobose, partial veil present or not 3

3a Short stipe-columella present, partial veil absent; fruit body looks like a white puffball, developing coarse brown scales in age; young not woody *Endoptychum agaricoides*

**FRUIT BODY** 2-10 cm high x 1-7 cm wide, always growing above ground. **SPORE CASE** irregular in form to heart-shaped, white in youth, becoming dingy to pale tan in age, scaly, one-layered. **GLEBA** white and spongy, then becoming yellowish and finally brown, gill-like. **STIPE-COLUMELLA** often appearing almost sessile, but base a rounded stalk tapering to a thick strand which anchors fungus to ground, upper portion a percurrent columella. Dehisces basally and longitudinally. **BASIDIOSPORES** 6.5-8 x 5.5-7 microns, smooth, subhyaline in KOH, dextrinoid in Melzer’s. **BASIDIA** 4-spored. **HABIT** and **HABITAT** on soil, especially wasteland, lawns and pastures after wet weather; summer and fall; scattered to gregarious. **COMMENTS** The authors find this a good edible in youth when gleba is soft and *white*. For them it has obligingly appeared in their garden spot. Very fibrous in maturity. [combined by some as *Chlorophyllum agaricoides*]

3b Stipe stout with partial veil present; fruit body agaric-like; spore case subglobose to depressed globose *Longia texensis*

**FRUIT BODY** 5-12 cm tall, often with only cap emerging above ground, consisting of capitate peridium, stout stipe narrowing to percurrent columella but widening near apex to underlie upper peridium. Typically annulate. **CAP** 2-7 cm x 3-9 cm wide, subglobose to broadly convex, “partial veil” at first closely appressed to stipe, breaking up to form ring on stipe, with upper portion left in form of pileus, smooth or forming loose appressed scales, cream at first, becoming grayish at maturity. **GLEBA** gill-like, forming into irregular cavities, free from stipe, becoming bone-brown to black. **STIPE-COLUMELLA** 2-3.5 cm at base, striate, concolorous with cap. **BASIDIOSPORES** blackish in deposit, 5-6.3 x 6.2-7.5 um, dark brown, subglobose to obovoid, smooth but sterigmatal scar prominent. **BASIDIA** 4-spored. **HABIT** and **HABITAT** in arid wastelands. Reported from Josephine County, Oregon. [Generally known as *Longula texensis* or *Agaricus texensis*.]

KEY II - TULOSTOMATACEAE

Genera occurring in Pacific Northwest

Although seldom collected except at maturity, all genera listed in this key develop underground and are puffball-like plants appearing only when the sterile portion elongates so that the mature spores may be dispersed. Often the stipe is buried deeply in the sandy soil.

Basically the genera are much alike except for certain adaptations allowing variations in the method of dehiscence. The gleba sac is initially two-layered, the capillitia well developed, and attached to the inside of the peridium.

1a Peridium opening circumscissilely or by the irregular breaking up of the endoperidium over the upper surface 2

1b Peridium opening by an apical mouth 3

2a Spore sac nearly flat below, opening around the basal margin; endoperidium coming off like a “skull cap” *Battarrea stevenii*

**SPORE CASE** 2-3 cm tall to 6 cm in width, cushion-shaped, situated on the expanded disc-like apex of stipe. **EXOPERIDIUM** soon flaking off. **ENDOPERIDIUM** membranous, at maturity splitting all the way round, drops off, leaving the rusty-colored gleba atop on a curved-like platform and exposed to elements. **STIPE** very long, 10-25 (-35) cm long x 5-20 mm wide, covered externally with brownish overlapping scales which may become more numerous and largest nearest the top, weathering to expose a cream-colored fluted exterior. Base inserted into a socket-like, dry, woody, two-layered “**VOLVA**”. **GLEBA** powdery. **BASIDIOSPORES** 5-7 um, more or less globose, punctate, sometimes briefly pedicelled, epispore pallid brown, wall 1 um thick. **CAPILLITIA** of 2 types: simple hyaline threads and elaters (unique to genus). Elaters are short cells with inner wall strengthened by conspicuous spiral thickened bands which it is believed move about snapping off adhering spores. **HABIT** and **HABITAT** on soil in deserts. Generally rare but known in SW Idaho. **COMMENTS** *B*. *stevenii*, the most widely distributed species, is separated from *B. phalloides* by its non-gelatinous “volva”, larger size, coarser stipe scales and differently colored basidiospores. *B. phalloides* identified at one PNW foray probably an import from California. [Some authors consider *Battarea stevenii* a synonym of *B. phalloides*.]

2b Spore case opening by irregular breaking up of endoperidium over the upper surface; fruit body appearing as a shaggy wine glass

*Phellorinia inquinans* (*= P. strobilina*)

**SPORE CASE** 3-5 cm tall x 2-4 cm wide, pear-shaped, over-all plant to 9 cm high. **EXOPERIDIUM** persistent and continuous with stipe, ochraceous, roughened. **ENDOPERIDIUM** also continuous with stipe, cream to white in color, breaking up so that the peridium forms a cup- to urn-like structure, baring the rusty-cinnamon gleba. **STIPE** 3-4 cm long, solid and woody, coarsely imbricate scaly. Base enlarged, sclerotium-like as a hardened mass of soil and mycelium from which may emerge more than one fruit body. **BASIDIOSPORES** 5-7 x 4.5-6 um, globose to subglobose with small rounded warts. **CAPILLITIA** simple, thick-walled, rarely septate, not abundant, tinted. **HABIT** and **HABITAT** on desert soils, solitary or 2-3 in cluster. Known from SW Idaho. **COMMENTS** [Some authors consider *P. inquinans* and *P. strobilina* to be synonyms of *Phellorinia herculeana*.]

3a (1b) Free volva present; stem flaring where it joins the spore case *Chlamydopus meyenianus*

**SPORE CASE** 1-2 cm high x 1.5-3.5 cm wide, dehiscing by plane apical pore. **EXOPERIDIUM** soon falling away, a sand case. **ENDOPERIDIUM** tough, membranous, yellowish bleaching to pallid. **STIPE** 5-35 cm x 12-35 mm wide, solid or with small central cavity, longitudinally grooved and enlarging upwards, silky fibrillose; base seated in a two-layered volva. **GLEBA** powdery, ochraceous to brownish. **BASIDIOSPORES** 6-9 (-10) um, globose, echinulate. **CAPILLITIA** well developed of long hyaline to tinted threads attached both to apex of stem and inner wall of peridium. **HABIT** and **HABITAT** on waste soil in arid regions; solitary to scattered. Known by authors to be found in SW Idaho and eastern Oregon.

3b No free volva present; stem fitting into *a socket in base of spore case* and not flaring above *Tulostoma* spp. (See KEYS III & IV)

INTRODUCTION TO TULOSTOMA

TULOSTOMA Persoon

Fruit body developing underground, appearing above ground at maturity, the spore case becoming elevated by the elongation of the stipe. Spore case globose to subglobose, two-layered; outer layer partly deciduous, the remnants forming an acorn-like cup or band around the base as a peridial sheath; inner layer encloses the gleba, opening by a pore (mouth) for dispersal of spores.

The powdery gleba consists of capillitia, usually well developed basidia and spores. Basidia a palisade, disappearing as gleba matures. Basidiospores are globose to subglobose (occasionally ovoid to slightly ellipsoid to somewhat misshapen), smooth or ornamented, if ornamented, as spines, fine or coarse warts, appearing as small plugs on the wall of the endospore and protruding into the gelatinous envelope of the epispore. Color of spores in deposit varying from shades of cinnamon- to rusty-brown, not very helpful in determination of species. Basidiospores size somewhat monotonous in range (3-) 4.2-7 (-8) um.

Author’s comments:

The genus *Tulostoma* presents special identification problems. Environmental conditions affect size, hence size not helpful as a criterion for identification, except in a few species where proportion of spore case to stipe etc. is relevant.

Separation of the outer layer over the fruit body’s top begins almost on emergence for some species while in others the outer layer remains for some time … thus collection of newly emerged specimen is desirable. Many species are fall fruiters and are not found until they have over-wintered. Weathering has then taken place. Exposed portions are often bleached, fibrils on stipe and peridial sheath erased, and appearance of mouth may be changed. Stems in soil tend to become darker. The peridial sheath, the shaggy ring surrounding the spore case base, is present on the described species after the exoperidium is shed. It may erode or disappear with age. The sheath is obscure in *T. verrucosum* which does not shed itS exoperidium.

Dr. David R. Hosford, Dept. of Biological Sciences, Central Washington University at Ellensburg whose research of the genus is the basis for the species listed herein states “I would guess only about three species can be recognized without microscopic features, and not 100% of the time.”

[Additional 2008 comments (by Ian Gibson):

Jorge Wright published a world monograph on *Tulostoma* in 1987:

Wright, Jorge E. 1987. “The genus *Tulostoma* (Gasteromycetes) - A World Monograph.” Bibliotheca Mycologica Band 113

Wright subsequently determined Ellen Trueblood’s *Tulostoma* collections at the University of Michigan from Idaho and Oregon to include the following species: *Tulostoma albocretaceum, T. beccarianum* (as *T. simulans*)*, T. chudaei, T. cretaceum, T. delbustoi, T. fusipes, T. fimbriatum* var*. campestre* (= *T. campestre*)*, T. fimbriatum* var. *egranulosum, T. fimbriatum* var. *tuberculatum* (= *T. tuberculatum*)*, T. giganteum, T. herteri, T. innermongolicum, T. jourdani, T. meridionale, T. meristostoma, T. mohavei, T. montanum, T. obscurum, T. occidentale, T. pulchellum* (=*T. poculatum*)*, T. squamosum* (=*T. verrucosum*)*,* and *T. striatum*. A Nancy Weber Smith collection at the University of Michigan from Idaho was determined by Wright as *T. vulgare*. Other collections at the University of Michigan from Idaho were determined by Wright as *T. obesum* (as *T. volvulatum* var. *obesum* and var. *elatum*). D. Prusso determined the following additional species from the Ellen Trueblood collections from Idaho and Oregon: *T. albicans, T. americanum, T. brumale, T. excentricum, T. involucratum,* and *T. thiersii*.

Descriptions for these species are available in the monograph and on the CD MatchMaker – Mushrooms of the Pacific Northwest. Note that a few other editorial comments on the 1985 key have been made in square brackets.]

[Additional 2017 comments (by Ian Gibson):

The species status of varieties of *T. fimbriatum* remains unresolved. The online Species Fungorum, accessed February 7, 2017, restored var. *tuberculatum*, var. *egranulosum*, and forma *fibrillosum* to species status, but left var. *campestre* with T. *fimbriatum*. MycoBank, accessed the same day, gave the varieties as the current names for var. *tuberculatum*, var. *egranulosum*, and var. *campestre* and gave three versions for forma *fibrillosum*. For T. *pulchellum* var. *subfuscum*, Species Fungorum restored the variety to species status and Mycobank gave both names. It is possible that J. Wright changed his mind after the monograph. He was co-author of an article that proposed *T. subfuscum* be renamed as a variety of *T. pulchellum*, but two years later annotated some of Ellen Trueblood’s collections as *T. subfuscum*.]

KEY III – MACROSCOPIC KEY TO SOME SPECIES OF GENUS TULOSTOMA

1a Mouth of spore case projecting as a circular glabrous tube with sharp edge 2

1b Mouth of spore case appearing in center of a slightly elevated mat, its edge eroded and fibrous unless well worn 6

2a Spore case width up to twice length of stipe; small stout gray to white fungus, endoperidium tannish; dry stipe white and deep furrowed *T. stuntzii*

**FRUIT BODY** less than 2 cm tall with stipe 5-9 mm in length, spore case 13-14 mm wide. **EXOPERIDIUM** gray, granular, deciduous except for narrow peridial sheath. **ENDOPERIDIUM** membranous, smooth to pitted, light brown, becoming white in age. **MOUTH** tubular, prominent, concolorous with endoperidium. **STIPE** 5-9 mm x 4-8 mm wide, white, striate, base broad, rounded, enclosed in sand cup. **BASIDIOSPORES** globose to subglobose, 4.5-6(-7) um, finely echinulate with spines, some apiculate.**CAPILLITIA** rare, when present hyaline, 4-7 um wide, smooth, thick-walled with few septa, only slightly swollen at septa to 5-10 um wide. **HABIT** and **HABITAT**in sand, semi-stabilized dune areas with rabbit brush (*Chrysothamnus* spp.); solitary; a fall species. Collections from Kittitas and Grant Counties, Washington.

2b Spore case width usually less than stipe length 3

3a Endoperidium with small gray ring surrounding base of mouth (may disappear with age); stipe reddish-brown and scaly *T. ferrugineum*

**FRUIT BODY** with a stipe to 5.5 cm long and spore case to 13 mm wide. **EXOPERIDIUM** granular, a thin sand layer mixed with thick-walled hyphae, soon retreating. **ENDOPERIDIUM** membranous, brownish-gray. **MOUTH** short tubular surrounded by a gray ring 1-1.5 mm wide which may fade in age. **STIPE** 2.2-5.5 cm tall x 3-4 mm wide, red-brown, scaly with bulbous base carrying a large conglomeration of sand, hyphae and roots, occasionally radicating. **BASIDIOSPORES** 5-6 (-7) um, globose to subglobose, strongly warted, warts flat-topped.**CAPILLITIA** 4-9 um wide, frequently branched, septate, joints often swollen to 6-12 um wide. **HABIT** and **HABITAT** in sandy areas, associated with rabbit brush (*Chrysothamnus*) and other shrubs; solitary to gregarious; fruiting late winter and spring. Collections from Pasco, Washington, area in juniper forest.

3b Gray ring absent; exoperidium membranous or granular 4

4a Exoperidium *membranous* with persistent flat-top angular warts; basal bulb as large or larger than spore case; occurring in rich soil in woods *T. verrucosum*

**FRUIT BODY** with a stipe to 9 cm long, base large, bulbous; spore case to 12 mm wide. **EXOPERIDIUM** persistent, breaking up into small angular, flat-topped, very thin walnut-brown warts adhering to the endoperidium. **ENDOPERIDIUM** membranous, rough from the adherent exoperidium. **MOUTH** tubular, not very prominent, slow in opening. **STIPE** tough, woody, pecan brown, 4-9 cm long x 3-6 mm wide, scaly with basal bulb large, firm, 7-20 mm thick. **BASIDIOSPORES** 4.2-5 um, irregularly globose with low blunt warts.**CAPILLITIA** 3-6 um wide, long slender branched, septate, not or only slightly swollen at septa. **HABIT** and **HABITAT** in rich soil in woods. One collection recorded from near Corvallis, Oregon. [Some authors say that *T. verrucosum* is a synonym of *T. squamosum*.]

4b Exoperidium granular; occurring in sandy desert soils 5

5a Exoperidium dark reddish-brown at first, often with adherent debris, long-lasting, breaking up with adhering sand particles; red-brown scaly stems may have mottled appearance *T. simulans*

**FRUIT BODY** with a stipe to 3 cm long and spore case to 15 mm wide. **EXOPERIDIUM** reddish-brown when fresh, but so covered with sand and earth as to obscure all details, a thin layer of delicate fibrils at first covering the debris-coated surface but soon shed. Exoperidium slowly wearing away to expose the endoperidium. **ENDOPERIDIUM** brownish to whitish. **MOUTH** a small apical pore with opening smooth on a tubular elevation. A narrow ring around mouth may become darker than surrounding area in age. **STIPE** 1.5-3 cm x 1.5-2.5 mm as dried, with covering of rusty-brown appressed to lacerate scales often appearing mottled. May become striate when dried. **BASIDIOSPORES** 4-7 um, globose to subglobose, surface appearing finely tuberculate.**CAPILLITIA** 4-6 um wide, branched, occasionally septate, some joints slightly swollen. **HABIT** and **HABITAT** on sandy soil; gregarious. Collections from central Washington, and Idaho. **COMMENTS** It is often very difficult to distinguish *T. simulans* from *T. jourdani*. [Some authors say that *T. beccarianum* is the correct name for *T. simulans*.]

5b Granular exoperidium completely deciduous, breaking up to expose pale endoperidium; stipe stout, white, often with mildewed appearance due to adhering white mycelium *T. jourdani*

**FRUIT BODY** with a stout stipe to 7 cm long and spore case to 15 mm wide. **EXOPERIDIUM** granular, completely deciduous to peridial sheath. **ENDOPERIDIUM** membranous, smooth, pinkish-buff to pinkish cinnamon. **MOUTH** tubular, prominent, enlarged at base. **STIPE** dingy white, 1.5-7 cm long x 4-6 mm wide, some stems covered with dirt and mycelium as if mildewed, others scaly to smooth; basal bulb 7-10 mm thick. **BASIDIOSPORES** 4.2-5.6 um, subglobose, nearly smooth, pedicellate, or if rough, then only a few pedicellate.**CAPILLITIA** wider than spore diameter, branched, almost solid, septa swollen. **HABIT** and **HABITAT** arid areas in sandy clay soil. Most common species of *Tulostoma* in our area but often variable in size and in spore ornamentation.

6a (1b) Stipe with numerous fibrils holding debris, long (5-7 cm), white and slimy at emergence, later pecan brown; endoperidium whitish *T. fibrillosum*

**FRUIT BODY** with stout stipe to 7 cm long and spore case to 15 mm wide. **EXOPERIDIUM** a granular sand coat sometimes remaining as a few brownish flakes. **ENDOPERIDIUM** a thin, white, tough membranous layer. **MOUTH** surrounded by a fibrillose, thin, slightly raised mat. **STIPE** walls thick and woody, pecan brown, 5-7 cm long x 6 mm wide, expanding abruptly into a thin woody bulb of sand and hyphae; stipe sulcate above, buried portion with light to heavy covering of mycelial strands holding debris. **BASIDIOSPORES** 5-6 um, subglobose, distinctly warty.**CAPILLITIA** 5-7 um wide, septa rare but then with rounded ends, not swollen. **HABIT** and **HABITAT** in sandy soil. In Idaho, Washington.

6b Stipe lacking numerous fibrils and without accompanying debris, pale rusty-brown; endoperidium pale tan to pale grayish 7

7a Exoperidium a sand case persistent for some time, then breaking up into small adherent warts, soon disappearing. Stipe long 3-6 (-10) cm, rusty-brown and striate; mouth plane *T. campestre*

**FRUIT BODY** with stipe to 6 cm long and spore case to 20 mm wide. **EXOPERIDIUM** containing much sand and breaking up into small areolate to almost granular subpersistent scales, but eventually deciduous. **ENDOPERIDIUM** smooth, pale tan to ashy gray in color. **MOUTH** a somewhat fibrillose disc opening by pore. **STIPE** 2-5 (-6) cm long x 2.5-4 mm wide, striate when dried, surface more or less pale rusty brown; the brown covering often broken up into lacerate scales and shrinking away from the spore case in drying so that it extends down and around the point of attachment as a **COLLAR**. **BASIDIOSPORES** 4.5-6.2 um, globose to subglobose, quite irregular in shape, warty, some with short pedicels.**CAPILLITIA** 4-8 um wide, branched, enlarged at septa. **HABIT** and **HABITAT** in sandy fields; single to gregarious. Collected from Multnomah County, Oregon and Yakima County, Washington. **COMMENTS** The manner in which the sand adheres to the spore case is a distinctive feature.[Also known as *T. fimbriatum* var*. campestre*.]

7b Species without distinctive macroscopic features and identifiable only with aid of microscope *T. striatum*

*T. poculatum*

*T. tuberculatum*

*T. striatum*

**FRUIT BODY** with stipe up to 6 cm long and spore case to 20 mm wide, more usual fruit bodies smaller. **EXOPERIDIUM** red-brown when fresh, fading to pallid tan and soon falling away, but leaving thick **PERIDIAL SHEATH** on lower portion of spore case with adhering sand. **ENDOPERIDIUM** pallid tan or dingy white, smooth and papery. **MOUTH** enclosed by a raised fibrillose zone. **STIPE** 2-6 cm long x 2-4 mm, pallid tan, striate, with slight basal enlargement. **BASIDIOSPORES** 4-8 um, globose to subglobose, *striate*.**CAPILLITIA** 4-8 um, somewhat flattened, sparingly septate, slightly swollen at joints. **HABIT** and **HABITAT** in sandy areas of arid PNW. Collections made in Lake Co., Oregon and Chelan Co., Washington.

*T. poculatum*

**FRUIT BODY** with stipe to 3 cm long and spore case up to 20 mm in width. **EXOPERIDIUM** strongly and permanently *membranous*, drying into a thin fragile envelope, soon deciduous in flakes and often leaving lacerate shreds of dried membrane around top of peridial sheath. **PERIDIAL SHEATH** a thick band of agglutinated hyphae and sand, 4-6 mm broad, often with a somewhat *cup-shaped flaring upper margin*. **ENDOPERIDIUM** perfectly smooth, tilleul buff weathering whitish. **MOUTH** a fibrillose mat surrounding the pore. **STIPE** 1-3 cm long x 3 mm wide, wood brown, walls thin and *fragile*, easily breaking especially near spore case; base slightly bulbous often with a spongy cushion of hyphae and sand extending 2/3 way up stipe. **BASIDIOSPORES** 4.2-5.6 um subglobose, almost smooth, may have pedicels.**CAPILLITIA** 4.0-7 um thick, sparingly branched, septa rare, joints swollen. **HABIT** and **HABITAT**in sand (sometimes black soil). Collected eastern Oregon and eastern Washington. [Some consider *T. poculatum* a synonym of *T. pulchellum*.]

*T. tuberculatum*

**FRUIT BODY** with a stipe to 3 cm long and spore case to 18 mm wide. **EXOPERIDIUM** a granular sand coat. **ENDOPERIDIUM** whitish to light buff, smooth and rather thin. **MOUTH** raised, fimbriate, roundish. **STIPE** 2-3 cm long x 3 mm wide, whitish to cinnamon in color, slightly enlarged at base. Some stipes easily breaking at stem apex. **BASIDIOSPORES** 3-6 um in diameter, often irregular, nearly smooth with occasional tuber-like warts.**CAPILLITIA** 4-8 um, sparingly septate, little swollen at joints. **HABIT** and **HABITAT**in sandy areas. Collections made in Washington and SW Idaho. **COMMENTS** This species might more properly be placed under *T. granulosum*.[Also known as *T. fimbriatum* var. *tuberculatum*.]

KEY IV – MICROSCOPIC KEY TO SOME SPECIES OF GENUS TULOSTOMA

(Using Microscopical and Macroscopical Features)

1a Mouth projecting as a circular glabrous tube with a sharp edge 2

1b Mouth appearing in the center of a mat, its edge eroded and fibrous unless well worn 6

2a Basidiospores smooth to slightly roughened, some pedicellate; exoperidium soon deciduous *T. jourdani*

2b Basidiospores ornamented; exoperidium deciduous or persistent 3

3a Basidiospores with spines; width of spore case up to two times length of stout stipe *T. stuntzii*

3b Basidiospores with warts; stipe longer than spore case width 4

4a Basidiospores strongly warty, warts truncate; mouth of spore case surrounded by a light gray zone; stipe red-brown and scaly *T. ferrugineum*

4b Basidiospore ornamentation without truncate ends; gray zone around mouth lacking; stipe features variable 5

5a Basidiospores with warts; exoperidium *persistent* and breaking up into small flat-top angular warts *T. verrucosum*

5b Basidiospores finely tuberculate; exoperidium covered with sand particles persistent for some time *T. simulans*

6a (1b) Basidiospores striate, large, 6-8 x 4-7 um, ellipsoid to ovoid; stipe striate *T. striatum*

6b Basidiospores smooth to tuberculate, average smaller than above, globose to subglobose; stipe striate or not 7

7a Basidiospores smooth to slightly verruculose; stipe fragile and may break easily at apex; long-lasting membranous exoperidium *T. poculatum*

7b Basidiospores ornamented; stipe fragile or not; exoperidium granular 8

8a Basidiospores smooth with occasional tuber-like warts, subglobose; stipe striate and may break easily at apex *T. tuberculatum*

8b Basidiospores warty to finely warty; stipe 2 to 7 cm long, not fragile 9

9a Basidospores with warts; stipe with numerous fibrils below ground accompanied by copious adhering material; mouth raised, convex *T. fibrillosum*

9b Basidiospores finely warted, quite irregular in shape, may have pedicels; stipe without fibrils; sand adheres to spore case; mouth plane *T. campestre*

SOME SUMMARY OBSERVATIONS ON GENUS TULOSTOMA

The following species exhibit macroscopic features that set them apart from the pack:

1. *T. stuntzii* Small, stout whitish spore case that is wider than stipe length.
2. *T. ferrugineum* Small gray ring surrounding base of the tubular mouth and a reddish-brown scaly stipe.
3. *T. verrucosum* Exoperidium persistent with small flat-top angular warts and basal bulb as large or wider than the spore case. Habitat: woods.
4. *T. fibrillosum* Stipe surface below ground level with numerous fibrils holding debris. Stipe long to 7 cm. If stipe fibrils lacking, see *T. campestre*.

Though size varies due to environmental conditions, it does offer a hint in separating out large species. Species with stipe lengths up to 6 cm or more include: *T. campestre, T. fibrillosum, T. jourdani, T. striatum* and *T. verrucosum*.

*T. striatum* and *T. poculatum* are reported as almost identical macroscopically.

*T. poculatum* and *T. tuberculatum* are reported to have fragile stipes breaking easily at or near the apex.

*T. fibrillosum* and *T. campestre* are difficult to separate when stipe fibrils of *T. fibrillosum* have worn away.

*T. jourdani* and *T. simulans* are close in macroscopic detail.

Most species are found in sandy desert habitats. *T. verrucosum* is an exception and is found in deep woods. *T. simulans* is sometimes reported from forested areas.

GLOSSARY

apiculate – pedicellate; short stem on basal end of spore

capillitia – specialized hyphae which with the spores form the gleba

circumscissilely dehiscing – torn or rupturing in a circular fashion

collar – space between the stem and the “acorn cup” which results as stem dries and shrinks; term may also apply to the appendiculate material adhering to the base of the cup surrounding the stem

dehiscing – rupturing or opening to shed spores

endoperidium – see peridium

exoperidium – see peridium

gleba – contents of spore case, made up of spores and capillitia

mouth – a defined apical pore (hole) through which spores are dispersed

peridial sheath – band of hyphae and sand surrounding the base of spore case; in *Tulostoma* often similar to the cup of an acorn

peridium – spore case or spore sac. In Tulostomataceae separated into two layers: exoperidium = outer layer, endoperidium = inner layer

sand case – layer of sand and hyphae adhering to exoperidium

spore case – sac-like structure containing the gleba; synonym: peridium

stipe – stem or stalk of fruiting body

stipe-columella – stem which extends into the gleba. Termed *percurrent* if extending through the gleba to the upper wall of the fruit body

volva – cuplike structure or socket surrounding the *base* of stipe

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